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## 7.4 The Ideal Lead Time For Tornado Warnings - A Look From The Customer's Perspective

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### 1. INTRODUCTION

Improving the amount of advanced warning time (lead time) for tornado warnings is one of the goals spelled out in the National Weather Service (NWS) Vision 2005 Strategic Plan (1999). Since the beginning of the NWS modernization effort, tornado warning lead times have increased from four to ten minutes, with the goal of 15 minutes set for 2005. In concert with increasing lead times, the NWS also has goals in place for increasing the probability of detection (POD) while decreasing the false alarm rate (FAR).

Accomplishing these goals will be no easy task. Rothfusz (2000) noted that forecasters may have reached a practical limit in tornado FARs until there are further advances in remote sensing technology and/or our understanding of tornadoes. The procurement of the weather event simulator (WES) should prove to be a very beneficial tool to aid in the understanding part of the equation. The WES simulates the AWIPS workstation used by the NWS. Forecasters are able to archive weather events as they occur and then review the case to gain a better understanding of the meteorological situation. In addition, training cases can be developed and administered to the operational staff at the beginning of the season (winter and convective events), to ensure operational proficiency.

When it comes to protecting the lives of citizens during hazardous weather situations such as tornadoes, another question that needs to be addressed is "How much lead time does the public want or need in order to take shelter?" This is a rather complex issue and won't be resolved in the confines of this paper. However, as a first look, the authors sent questionnaires to two user groups in the Hastings Nebraska county warning area (GID CWA). One group included elementary and secondary schools, while the other consisted of hospitals and assisted living facilities (HAL). A cover letter was included with the questionnaire explaining our goals and also to define warning lead time. The number of responses returned was encouraging, confirming the importance of the subject.

The two groups sampled represent parts of the population where one, or maybe a couple of people, have to make decisions that affect many lives, namely when to take shelter. There are other organizations in a similar circumstance, but as a starting point schools and HALs were selected.

### 2. RESULTS FROM SCHOOLS

Responses were received from 52 school administrators across the NWS Hastings CWA. Approximately 170 letters were sent out, but in districts where more than one school existed, the administrator was asked to distribute the form to each principal. This made it impossible to gage the percentage of respondents, but overall the number was respectable and represented a good cross section of the CWA. Several questions dealt with generalities such as number of students, tornado action plans and drills, and revealed the following: The number of students per school ranged from 15 to 1000, with an average size of 292. Every school that responded had a tornado action plan in place. All schools, with one exception, reported they had at least one tornado drill per year.

One question was phrased, "What do you feel is the ideal lead time for a tornado warning?" The average was 18.6 minutes while the median was 15 minutes (Table 1). A few respondents noted they would like 60 minutes of lead time, while one stated that three days would be ideal (he also realized this wasn't possible). On the other end of the spectrum, several noted that anything between five and ten minutes was fine, while one person commented that anything over two minutes would work.

Another question was "What is the minimum amount of time needed to get your students to shelter?" The average was 4.1 minutes, while the median was 3 minutes. Responses ranged from 1 to 20 minutes. The 20 minute reply was from the school with 1000 students.

Administrators were also asked "Is there an amount of time you feel is too much warning?" Thirty seven percent answered "Yes" while 42% indicated "no". Those who chose not to answer the question totaled 21%, indicating the question may have caused some confusion among respondents. Of those who answered in the affirmative and offered a comment, most said that cramped quarters and comfort level of the students posed the largest problems.

"Where is the primary place your students seek shelter?" was another question asked. Results were encouraging as everyone listed proper shelter locations such as basements, and interior rooms without windows such as locker rooms, restrooms, and interior hallways. Fortunately, none of the schools had their students take shelter in gymnasiums, auditoriums, or in classrooms with windows.

Another question was "What is your primary

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means of notification for tornado warnings?" School officials were asked to choose from the following list: TV, NOAA Weather Radio (NWR), Commercial Radio, Outdoor Sirens, Scanner, None, Other (Table 2). Several chose more than one source so the total exceeded 100%. NWR topped the list at 44%. This result may actually be a little higher as 14% noted scanners as a source and NWR is one of the frequencies available on scanners. Outdoor sirens received the second highest response at 38%. The number of schools who relied solely on outdoor sirens was 14%. Those getting information from commercial radio stations equaled 34%. Ten percent received information from television, while 14% checked the "other" category. The most common response in the "other" category was a call from the local sheriff's office.

The final question was, "When a tornado warning is issued for your county, how does your school react?" (Table 3). They had a choice of the following answers and again some chose more than one answer (results in parenthesis). Immediately enact tornado action plan (39%). Wait a certain time, or for reports of the tornado being a certain distance away (29%). Wait for an actual report of a tornado only (10%). Wait to see if your town is listed in the warning before making a decision (31%). Other (15%). The responses of those in the "other" column were enlightening. One school relies on the Emergency Manager to notify them (he is also a school employee). Another one noted that they would look outside for themselves before making the decision. One school official waits for the fire department to notify him, while another listens to NWR but also checks the radar (presumably on the Internet).

### 3. RESULTS FROM HOSPITALS AND ASSISTED LIVING FACILITIES

Another customer dynamic that we sampled, also responsible for a relatively large group of people, were hospitals and assisted living facilities in south central Nebraska and north central Kansas. A total of 60 responses (out of 97 sent out) were received from area hospitals and assisted living facilities in the NWS Hastings CWA. Of the responses received, the health care agencies are responsible for the care and well-being of occupants ranging from 14 to 250 people, with an average of 64 for each facility.

First and foremost, each health care facility that responded had some sort of working tornado action plan in place. Furthermore, each conduct a drill on a yearly basis.

As was the case with the area schools, the question of "What is the minimum amount of time needed to get everyone to shelter?" was posed. Responses averaged 17.1 minutes, while the median response was 15 minutes.

A complicating circumstance, that many health

care managers noted concerning this question, was the fact that staffing is typically reduced dramatically in the evening and overnight hours. In considering the factors that the number of patients would relatively remain the same independent of time of day, and the evening climatological norm for severe weather in the Central Plains region, this can create an extra challenge for the care workers at these facilities.

Ultimately, this means that workers at the health care facilities are responsible for the well-being of an inordinate amount of people during the evening and overnight hours. A common theme by respondents was that during the daytime hours, the staff might only need 10 to 15 minutes to get all patients to their designated safe areas; conversely 20 to 30 minutes are needed when staffing levels are typically reduced in the evening and overnight. For example, one elaboration by an assisted living administrator included, "Lead Time is much more crucial to us at night after 11:00 pm. This is when we are staffed at our lowest."

Management of these facilities were then asked "What do you feel is the ideal lead time for a tornado warning?" The health care managers had been given an brief explanation of this question in the introductory letter, including a statement of the current state of the science and technology. The average of the responses was just under 34 minutes, with a median of 30 minutes. By far, a response of 30 minutes was the most common answer.

When asked "Is there an amount of time you feel is too much warning?" There were 16 "Yes" responses, and 21 "No" responses. In general, in spite of an accompanying explanation, this seemed to be a difficult question for the health care managers to grasp. Thus, the authors realize the validity of the results may be questionable.

Never-the-less, several interesting perspectives were gained. Accompanying quotes included, "Too much lead time results in people becoming complacent and deciding there is no danger and then leaving the safe location"; "Anything longer than 30 minutes, people get agitated and stressed"; while another included "Limited space to residents" as a consideration for too much warning lead time.

The most common notification means for tornado warnings was NWR (44%), followed closely by outdoor sirens (32%), television (29%), and scanner (25%). (Table 2). Only two administrators noted that they relied solely on outdoor sirens.

Next we asked how they react once a tornado warning has been issued. The vast majority of responses (86%) indicated that HALs immediately enact their action plan to get everyone to their respective designated shelters. This result was not surprising when considering the prior indications of time needed to get all residents to safety.

Finally, we polled this group about their response to severe thunderstorm warnings. Over the last several years, there has been growing speculation that the general public may be growing lackadaisical to NWS severe thunderstorm warnings, namely because of large number of warnings for 0.75 inch hail. Although only a mere fraction of the population, our responses did not indicate that this was the case. In all, 86 percent (44 responses) indicated that they took the same precautions for the issuance of a severe thunderstorm warning as they would a tornado warning.

#### 4. SUMMARY

Issuing timely and accurate severe weather warnings is an on-going mission of the NWS. Increasing lead time while improving the POD and decreasing FAR standards continue to be raised. This study is the first attempt by the authors to investigate the question, "Is there an ideal lead time for tornado warnings?" We realize that issuing a tornado warning is only one facet of the warning process. Preparedness and community response before and during the event are also critical factors.

Among the meteorological community, the issue of increasing lead times has been open for debate. In a guest editorial for *Weatherzine*, Doswell (1999) noted "It's hard to imagine any real need for warnings with lead times longer than 32 minutes! In fact, it's possible that longer lead times would be less effective because they might not convey a strong enough sense of urgency."

Replies to two questions from our survey seem to shed some light in answering the lead time question. "What do you feel is the ideal lead time?" and "What is the minimum amount of time needed to get your residents to shelter?" Median ideal lead time responses ranged from 15 minutes for schools, to 30 minutes for HALs. Median minimum time responses ranged from three minutes for schools to 15 minutes for HALs. Given the profile of the residents in each group, it is not surprising to see a gap between the groups as most students can move quickly to shelter, while many of those in the HAL group need assistance. Replies to the ideal lead time question reveals some light as to what administrators would like for advanced warning. However, the minimum time question shows what these groups really need, and these replies seem to be more in line with what is currently practical given the current state of the science and technology. That being the case, 15 minutes would be a reasonable goal. Of course this only covers the average situation and doesn't take into account cases noted above such as needing extra time to move people in the evening and overnight due to reduced staffing.

It was encouraging to note that both groups responded 100% to the question of having an action plan for severe weather. They also know where to move people in order to provide the safest location in their

facility. The HAL group seemed to react much quicker to warnings based on the reaction to NWS tornado warning question, as 87% said they immediately enacted their plan versus 39% for schools. This may be related to the amount of time needed to get people to shelter.

The fact that at least 44% of both groups utilized NWR as a source for warnings and that most locations relied on several sources was viewed as a positive. The finding that 14% of the schools relied solely on outdoor warning sirens was disturbing.

Results of this study will be used by NWS Hastings to further educate those responsible for directing people to shelter when a warning is issued. Over the past year, the office has had over fifty school administrators participate in our Weatherwise-101 program (Moritz et al. 1998), which gives them the opportunity to spend three hours at our office learning about the NWS, its mission, and weather safety.

The authors plan to continue to sample various populations and community groups in an effort to better determine the "ideal" lead time for tornado warnings.

#### 5. ACKNOWLEDGMENTS

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## 7. TABLES

TABLE 1: Questionnaire responses concerning the minimum and ideal lead times needed for taking shelter during tornado warnings.

Reaction Times to NWS Tornado Warnings	Schools		Hospitals and Assisted Living	
	Mean (Minutes)	Median (Minutes)	Mean (Minutes)	Median (Minutes)
Minimum amount of time needed to get people to shelter	4.1	3	17.1	15
What do you feel is the ideal lead time for a tornado warning	18.4	15	33.6	30

TABLE 2: Primary means of receiving notification for tornado warnings.

Primary Means of Notification	Schools	Hospitals and Assisted Living
Television	10%	29%
NOAA Weather Radio	44%	44%
Commercial Radio	34%	17%
Outdoor Sirens	38%	32%
Scanner	14%	25%
None	0%	0%
Other	14%	17%

TABLE 3: Initial reaction of institution when a tornado warning is issued.

Reaction to NWS Tornado Warning	Schools	Hospitals and Assisted Living
Immediately Enact Tornado Action Plan	39%	87%
Wait an amount of time or for reports of tornado being certain distance away	29%	7%
Actual Sighted Tornado Only	10%	3%
Depends whether town is mentioned in warning	31%	7%
Other	15%	5%